

# Cost Effective Computerized Decision Support: Tracking Caregiver Acceptance at the Point of Care

C. Jane Wallace, R.N., M.S., C.C.R.N., Sandy Metcalf, B.S., R.R.T., Xiaoping Zhang, M.D., A. Tupper Kinder, B.S., Loren Greenway, B.S., R.R.T., R.C.P., Alan H. Morris, M.D.,

\*LDS Hospital Division of Pulmonary and Respiratory Care Services, Salt Lake City, Utah

## ABSTRACT

*We implemented a computerized decision support tool to standardize the administration of supplemental oxygen (O<sub>2</sub>) therapy in the acute care (non-ICU) hospital setting. Caregiver acceptance of the computerized oxygen therapy protocol (COTP) instructions was measured to determine the clinical performance of the computerized decision support tool. 49.6% of instructions generated were followed by the clinical caregiver, and 16.8% of instructions generated were explicitly acknowledged by the user through the COTP computer interface. Despite this low caregiver response rate, significant favorable changes in the administration of oxygen were observed. This paper is focused on the issues of general importance the caregiver response rate raises for the implementation and clinical use of computerized decision support tools, including: (1) limitations of the user interface and (2) inherent difficulty in changing long-standing practice patterns.*

## INTRODUCTION

Standardization of human decision making has been shown to lead to cost effective outcomes in the industrial world (1). A growing body of evidence supports this conclusion in the medical world (2-9). Process control in medical care is primarily achieved through the use of clinical care guidelines. Most of these guidelines are too general and leave much up to the individual caregiver's judgment (10, 11) Effective standardization of medical care-including content and process control-requires that the implementer(s) of the guidelines be able to track how well the guidelines are followed.

Guidelines for the administration of O<sub>2</sub> therapy are available (12), but the efficacy of the existing guidelines has not been studied in a prospective clinical trial. The difficulties in assuring proper O<sub>2</sub> utilization according to standard indications, and costs associated with either nonessential use or lack of use of O<sub>2</sub> when indicated are described and include: (1) monitoring compliance with standards written on paper is time consuming but must be done in order to understand and sustain conformance with the standards (13); (2) repeated occurrences of hypoxemia are rarely documented in the medical record (14); (3) use of O<sub>2</sub> has been shown to change very little in response to general efforts to contain costs of respiratory therapy (15); (4) O<sub>2</sub> use in the non-ICU setting is excessive

(16); and (5) the per-patient, per-day costs of O<sub>2</sub> administration appear innocuous until one considers the large number of patients who receive oxygen (17). We utilized an existing information system at our hospital to characterize the O<sub>2</sub> administration practice patterns at our hospital and found indiscriminate use of O<sub>2</sub>. The nursing clinical practice committee on a busy medical service collaborated with us to help them institute standards for O<sub>2</sub> administration.

In order respond to the needs of the clinical care environment and to promote the discriminate use of O<sub>2</sub> in the non-ICU setting, we developed and implemented a COTP on one medical and one surgical acute care unit. The COTP was based on published guidelines (12, 18) and was designed to provide the user with specific, executable instructions at the point of care. Because of anticipated difficulties (based on available literature and local experience with implementation of other guidelines in the acute care areas) with implementing the COTP, the caregiver response to the COTP was a major concern. In addition to providing the caregiver with repeated opportunities for feedback to the developers using a one-to-one and regular group meeting approach, we measured explicit acknowledgment of instructions and actions taken by the clinical caregiver to ascertain the acceptance of the COTP.

## METHODS

Preliminary work for this project was begun with an initial meeting of the nurse management council to inform them of the goals of the project. There were no major objections to the project and the council gave its support. The nursing staff members on three areas considered for the pilot project were then approached in their regular staff meetings. They completed a short questionnaire designed to elicit their perception of the need for a standard, computerized approach to O<sub>2</sub> administration. Over 95% of the respondents indicated strong support for the idea of developing the COTP. The clinical practice committee of a busy medicine service was then approached, gave their enthusiastic approval for the project, and indicated a willingness to collaborate in the development stages since they had recently identified the inconsistency in the administration of O<sub>2</sub> as an important practice issue. The nurse manager and clinical practice committee of a second surgical service also agreed to participate in the project after the initial development and testing was done on the medicine service. The medical staff were

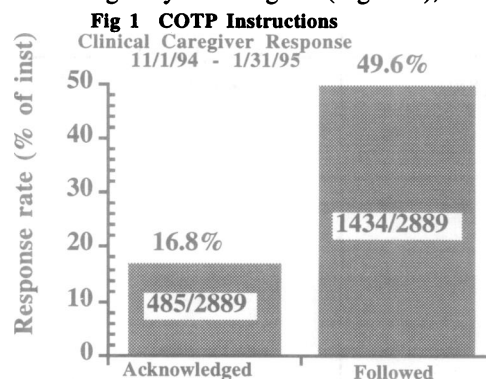
approached through their staff meetings and with a personal letter outlining the project goals, COTP general rules, and a request for specific objections to the project. There were no major objections from the medical staff, and the majority of their responses to the idea were positive.

Pulse oximetry measurements and associated O2 therapy data from all patients admitted to both acute care units between 1/1/94 and 3/31/94 were downloaded from an existing hospital information system (HELP) Tandem computer into an Oracle relational data base. These data established the historical control group. The COTP was developed using a previously described method of iterative refinement (19, 20). The computerized version was introduced on the medicine unit in August and the surgical unit in October 1994. Data for the test group were collected from 11/1/94 to 1/31/95. The content of the specific instruction and the staff response to the instruction (accepted, declined or neither), were collected in addition to the pulse oximetry measurements and associated O2 therapy data in the test group.

A description of the acute care area needs and the user interface is relevant at this point because the COTP developers' experience with introducing computerized decision support was limited to the ICU setting up to this time. The acute care units in the hospital differ from the ICU in several important ways (from the perspective of implementing a new program of any kind): (1) the nurse/patient ratio is substantially smaller on the acute care area, varying from 1:2 on average in the ICU to 1:8 on average in the acute care area; (2) the bedside staff on the acute care unit is much larger in terms of initial and ongoing training needs and gathering feedback; (3) the medical staff involved is much larger and requires greater effort on the part of the implementers to inform and assure agreement with the COTP goals; (4) the targeted patient population (all patients on the units were enrolled in the COTP) was much larger. The developers debated, but chose not to configure the COTP to force the user to acknowledge and respond to instructions before issuing a new one for the following reasons: (1) limited resources related largely to staffing on the acute care unit were a concern for the COTP developers, and (2) there was a desire to comply with a previously existing user interface standard that did not require user acknowledgment of or response to instructions. This standard allowed the user to review the instructions and either: (1) enter a four keystroke indicator of accepting the instruction, (2) enter a four keystroke indicator of declining the instruction, or (3) hit the escape key and have no stored indicator of the caregiver's intent to accept or decline the instruction. The developers initially chose not to use an option to page the responsible caregiver when an instruction was generated. The notification to the caregiver that instructions were pending was in the form of a single character "A" (for alert) that flashed on and off in the lower left hand corner of the screen.

## RESULTS

339 patients with 6362 pulse oximetry measurements and associated O2 therapy status were included in the control group and 269 patients with 5034 pulse oximetry measurements and associated O2 therapy status were included in the control group. In the test group, 16.8% of instructions were explicitly acknowledged by the caregiver (Figure 1), and 49.6%

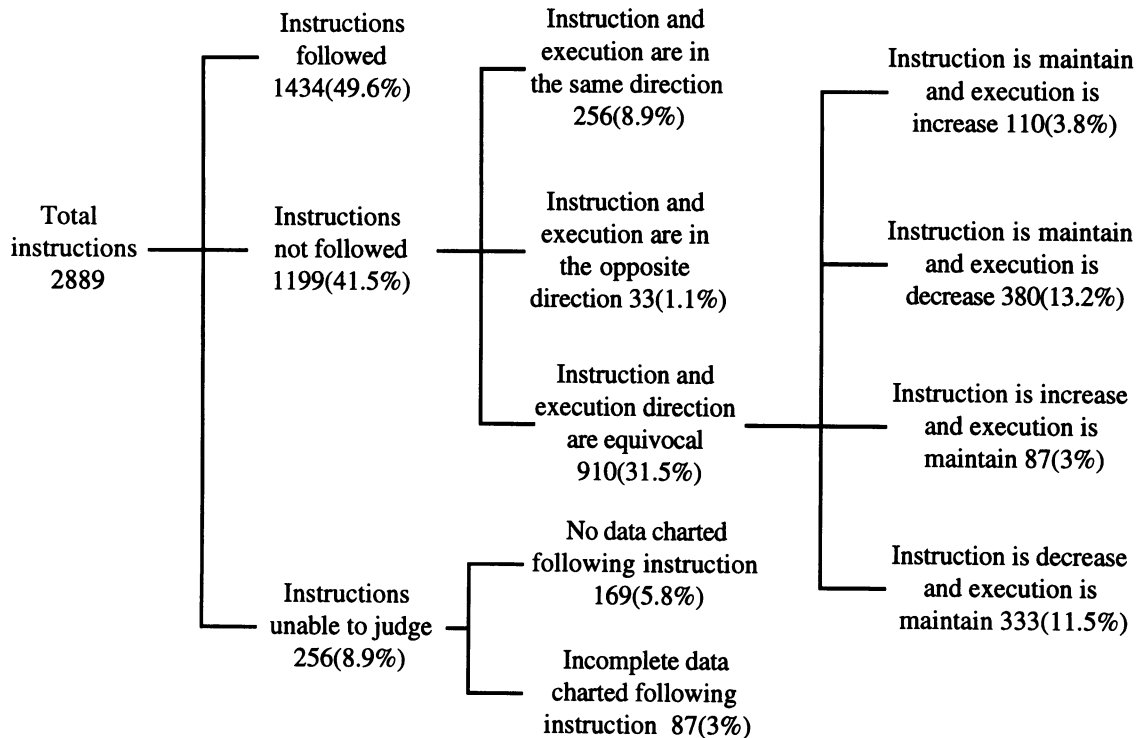


of all instructions issued were followed (Figure 2). The caregiver's actions for the instructions not followed are also shown in Figure 2. When questioned, the caregivers cited the following problems with the user interface as barriers to using the COTP: (1) the difficulty of using the computer interface to acknowledge instructions, (2) the fact that the flashing "A" to alert the caregiver of pending instructions was difficult to notice and was frequently ignored, (3) the need for a useful report that provided timely feedback to the clinical staff about protocol performance in general and for specific patients that need attention (those with evidence of under- or overutilization of O2). Despite this low response rate, we observed a 46% reduction in the percent of time (expressed as a percent of the total length of time on the acute care unit) on average that the patients spent with insufficient use of O2 (control group=7.2%. test group=3.9%.  $p=0.0004$ ). The percent of time (expressed as a percent of the total length of time on the acute care unit) patients spent with excessive use of O2 was not significantly reduced (control group=30.9%. test group=29.4%,  $p=0.412$ ).

## CONCLUSIONS

We concluded that the COTP was associated with a favorable reduction in the length of time patients spent in with insufficient use of O2 despite the low caregiver response rate to the instructions. The reduction in risk to the patients and to the institution from the underutilization of O2 is potentially substantial. The time spent with excessive use of O2 was not reduced, most likely because these busy clinicians use the protocol to respond to hypoxemia but do not view reduction of unnecessary therapy as a high priority (when questioned, the caregivers offered this as a potential explanation). The investigators and the caregivers both attribute the low caregiver response to the user interface limitations.

**Fig 2. Performance Evaluation of Oxygen Therapy Protocol Instructions  
From November 94 to January 95**



## IMPLICATIONS

Implementing robust decision support that provides specific, executable instructions at the point of care and allows caregivers and developers to track the system performance requires a measure of the actual caregiver acceptance and execution of the instructions. User interfaces should be: (1) designed to measure actual caregiver response, (2) easy for the caregiver to use, (3) provide short-term feedback that helps the users at the point-of-care, and (4) provide short- and long-term feedback to the developers and caregivers so that the system can be iteratively refined. We are in the process of providing several enhancements to the COTP user interface that will meet the above criteria. The enhancements include: (1) implementing logic that will automatically accept the instruction for the user or require the user to respond to instructions that have not been accepted before issuing new ones; (2) providing reminders through a paging system designed to automatically page the responsible caregivers when instructions have been pending for an unacceptable length of time; (3) providing shift reports that are designed to provide the status of COTP performance, including warnings about the under- or overutilization of O<sub>2</sub>, for the past shift (or for a user specified time period); (4) enlisting more help from the Respiratory Therapy staff in providing response to the COTP instructions; (5) provide weekly reports for administrators or supervisory personnel interested in tracking oxygen utilization within the institution. If the enhanced user interface results in a reduction in the overutilization of O<sub>2</sub> by 50%, we estimate that the cost savings to the hospital for the two acute care units currently using

the protocol would be about \$13,000.00. Expansion to other units and other hospitals within the larger institution could provide substantial, ongoing cost savings that would offset the necessary costs of developing a high quality system.

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